DESIGNING AN EFFECTIVE EMERGENCY OPERATIONS CENTER

Designing an Effective Emergency Operations Center for the City of Martinsville, Virginia

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Certification Statement

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed: _____

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Abstract

The research problem is that currently the City of Martinsville has an emergency operations center that is not functional in its design and use of technology, which causes confusion and inconsistencies when the emergency operations center is activated. The purpose of this applied research paper is to identify the best industry practices and designs for effective emergency operations centers, and to determine which design elements and technologies the City should integrate into its center. The descriptive research method was used for this applied research project. Literature was explored to answer the following research questions: (a) What are considered effective design characteristics of emergency operations centers? (b) What are considered industry best practices for the use of technology in emergency operations centers? (c) What factors should the City of Martinsville use in redesigning its emergency operations center? In addition, interviews and personal observations at neighboring emergency operations centers were conducted to gather additional information to answer the research questions. These interviews and personal observations were conducted to ascertain how emergency operations centers in other localities in southwest Virginia are designed, what floor plan was utilized and what technologies they have incorporated into their emergency operations center. The results of this applied research project revealed several suggestions for emergency operations center design, organizational structure and the use of technology. It is recommended that the City redesign its emergency operations center, incorporating a standard organizational structure for the emergency operations center, a standard system for information management and utilize technology to enhance information management systems.

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Introduction

When an event, such as a natural disaster, occurs and the resulting emergency overwhelms the affected locality, a safe and secure location must be available where high level emergency managers can meet to effectively manage response activities and mitigation efforts (Larson, 2002a; Moore, 1999). This is usually done through a local or state emergency operations center (Larson, 2002a). The emergency operations center is a tool that emergency managers can use to bring together essential personnel to coordinate the response to and mitigation of emergencies (Larson, 2006; Shouldis, 2010). However, in an article in the Journal of Contingencies and Crisis Management, Ronald Perry (2003) states, "…the use of EOCs [emergency operations centers], particularly in smaller jurisdictions, remain sporadic, sometimes improvisational and poorly understood" (p. 151).

The research problem is that currently the City of Martinsville has an emergency operations center that is not functional in its design and use of technology, which causes confusion and inconsistencies when the emergency operations center is activated. The purpose of this applied research paper is to identify the best industry practices and designs for effective emergency operations centers, and to determine which design elements and technologies the City should integrate into its center. The descriptive research method is used for this applied research project. The research approach will entail evaluating collected literature on emergency operations center design, as well as identifying industry best practices for the use of

technology in emergency operations centers. Literature will be explored to answer the following research questions: (a) What are considered effective design characteristics of emergency operations centers? (b) What are considered industry best practices for the use of technology in emergency operations centers? (c) What factors should the City of Martinsville use in redesigning its emergency operations center?

Background and Significance

The Martinsville Fire & EMS Department is a small career/volunteer combination department that covers eleven square miles, serving approximately 14,500 citizens from two stations. The department is comprised of twenty-nine uniformed full-time employees, three civilian full-time employees, nine uniformed part-time employees, and fifteen volunteers. The department is composed of four divisions that include: Administration, Operations, Inspections & Code Enforcement and Emergency Management & Safety. Division full-time staffing levels are outlined in Table 1.

Table 1: *Full-Time Personnel Division Assignments.*

Division	**Personnel**
Operations	25
Administration	2
Inspections & Code Enforcement	4
Emergency Management & Safety	1
Total:	**32**

The department provides fire prevention and protection services, emergency medical services (EMS) at the advanced life support (ALS) level, and operations level response to hazardous

materials incidents. In addition, emergency management functions and citywide safety programs are coordinated and managed through the department.

The City of Martinsville is a small community located in the foothills of the Blue Ridge Mountains, 45 miles south of Roanoke, Virginia. Martinsville has a Council/Manager form of government. Martinsville attracts visitors from all over the world for NASCAR Sprint Cup Series, Camping World Truck Series, and Late Model Stock Car Racing at Martinsville Speedway. Cultural activities include the Virginia Museum of Natural History and the Piedmont Arts Association.

During the late 1990's the city lost many jobs in the furniture and textile industries due to the North American Free Trade Act (NAFTA) and the expanding global economy. Unemployment rates skyrocketed, and Martinsville consistently has had the highest unemployment rate in Virginia. For April, 2010, Martinsville's unemployment rate was 21.7% as compared to the Virginia Statewide average of 6.7% (Virginia Employment Commission [VEC], 2010). The city has also experienced a 5% reduction in its population from July 1, 2000 to July 1, 2007 (United States Census Bureau [USCB], 2007). Population estimates for the City of Martinsville are listed in Table 2 (USCB, 2007).

Table 2: *Annual Estimates of the Population for City of Martinsville.*

	7/1/2000	7/1/2007	Difference	% Difference
Estimate	15,356	14,578	- 778	- 5%

The outcome of these facts has resulted in a diminishing tax base, which has had an adverse effect on the Fire & EMS Department's budget.

The Fire & EMS department's Fiscal Year 10/11 Total Budget is $2,388,411, of which $2,087,598 is personnel expenses. For the past several years the only adjustments to the department's operating budget have been minor line item reductions, and a Capital Budget has been virtually non-existent. However, this fiscal year our overall Operating Budget was reduced by 31%. In addition, the Governor of Virginia has reduced the amount of local government funding this current fiscal year and further reductions are expected. The department may be forced to reduce its budget by five, ten or fifteen percent as a result. The city, in its current economic state, cannot afford any budgetary increases that are not justified by significant improvements in the delivery of services.

The City of Martinsville is joint partners with Henry County in the Martinsville-Henry County Communications Center. Located in Henry County, the Martinsville-Henry County Communications Center, with Enhanced 9-1-1, provides for receipt and dispatch of both emergency and non-emergency calls for service for law enforcement, emergency medical services, and fire service for both the City of Martinsville and Henry County. The Communications Center functions independently of both the Sheriff's Office and Police Department, the traditional agencies to oversee such operations. The Communications Center is governed by a six-member Board of Directors which consists of: the Henry County Administrator, Henry County Sheriff, Henry County Public Safety Director, Martinsville City Manager, Martinsville Police Chief and the Martinsville Fire & EMS Chief. The Communications Center Director performs his duties under the general supervision of the Communications Center Board of Directors. In addition, a joint emergency operations center is co-located within the Martinsville-Henry County Communications Center. This joint emergency operations center

is only staffed when activated, and the site serves a dual role as a meeting/training room for the Martinsville-Henry County Communications Center.

In 2007, city officials made the decision to establish a separate emergency operations center within the City of Martinsville. It was determined that it was not feasible for City department heads to travel into Henry County to the joint emergency operations center when the resources (files, maps, emergency operations plans, etc.) they needed access to were located in their offices. It was hypothesized that city department heads would become more efficient and organized by operating from a central location within the city. Furthermore, it was felt that a city emergency operations center would provide better coordination of city resources during an emergency event. A city liaison would be placed in the joint emergency operations center to ensure communication and coordination with county emergency managers.

With the economic condition of the city, a new facility was not an option. City officials determined that the city's Headquarters Fire & EMS Station was the best suited site for an emergency operations center. The Headquarters Station is located beside the City Municipal Building and is tied into the city's intranet by fiber optic cable. The station had a thirty foot by twenty foot training room with enough tables and chairs to seat twenty people. In addition, the room had one flat screen television connected to our local cable television provider and equipped with SMART Board Technology interface and one multimedia projector equipped with a SMART Board Sympodium, both connected to a dedicated training desktop computer. This location can be secured, and is adjacent to the station's kitchen. The station also has a dormitory area with shower and restroom facilities.

With limited funding available, few modifications were made to the site. A grant was secured to purchase a backup generator, which was bought and installed. Additional phone and fiber optic lines and connections were installed throughout the training room ceiling. Wireless routers were also installed to provide easier access to the internet and city's intranet. No other technologies were incorporated into the new emergency operations center. In addition, limited training was done with the new facility and no standard operating procedures were written to outline the setup or operations of the new city emergency operations center.

In February of 2010, the region experienced a significant winter storm that produced near record snowfalls and widespread power outages. The city activated its new emergency operations center to handle the influx of calls pertaining to the storm. This first real life activation of the city emergency operations center brought to light several flaws. First, the setup of the tables and chairs was not the same arrangement used during previous training exercises, which caused some confusion within the center. The wireless routers failed to work when department heads attempted to wirelessly connect their laptops to the city's intranet. This issue was fixed, but we were approximately three hours into the event. The computer and other technologies available were never really used. Finally, no ICS forms were used until the third operational period, approximately eighteen hours into event.

After the event a critique was done. The participants felt that as a whole the event was handled appropriately; however, the new emergency operations center initially was more of a hindrance than an effective management tool. Many of the reasons cited above were discussed. The primary contributing factor identified was the site itself was not properly

planned and designed for effective and efficient operations during an emergency event. Sadly, to date, no further action has been taken.

The future impact of the city's emergency operations center is a concern of Fire & EMS Department Administration. This applied research project is significant to our department and the City of Martinsville, as the information obtained through this research process will assist our City Administration and Emergency Management Coordinator in redesigning the current site and implementing standard operating guidelines for the setup and use technology within the city's emergency operations center.

This applied research project is directly related to the National Fire Academy's Executive Analysis of Fire Service Operations in Emergency Management course. "The goal of this course, Executive Analysis of Fire Service Operations in Emergency Management, is to prepare senior fire officers in the administrative functions necessary to manage the operational component of a fire department effectively" (United States Department of Homeland Security [DHS], 2009, p. SM 1-3). The Executive Analysis of Fire Service Operations in Emergency Management is the third course in the National Fire Academy's Executive Fire Officer Program. This course provided the Executive Fire Officer student with the necessary knowledge, skills and abilities to effectively and efficiently manage large scale multiagency emergency events within their locality (DHS, 2009). This applied research project will utilize the knowledge gained during this course to identify industry best practices for emergency operations center design and the use of technology.

The United States Fire Administration (2010) website lists the following goals in their strategic plan:

> (1) Reduce risk at the local level through prevention and mitigation. (2) Improve local planning and preparedness. (3) Improve the fire and emergency services' capability for response to, and recovery, from all hazards. (4) Improve the fire and emergency services' professional status. (5) Lead the Nation's fire and emergency services by establishing and sustaining USFA as a dynamic organization. (Goals Section)

This applied research project supports these goals by conducting research to identify industry best practices that will improve the design and use of technology in Martinsville's emergency operations center. The knowledge gained through this applied research project will allow City Administration and Emergency Management staff to develop an emergency operations center that will improve the city's response to and mitigation of large scale emergency events.

Literature Review

The objective of the literature review process is to collect and evaluate available literature on emergency operations center design and use of technology. Research was conducted at the National Fire Academy's Learning Resource Center located in Emmitsburg, Maryland. In addition, research was online through the Homeland Security Digital Library Database. Literature examined for this applied research project included written texts, scholarly journals, trade journals, fire service publications, and internet databases and sites. The focus of the research was to identify relevant sources that directly relate to this research problem.

Professor Ronald Perry (1995) stated, "The community emergency operations centre (EOC) represents the centre of activity and direction when it is necessary to deal with the impact of natural or technological disaster" (p. 37). These sites are the centers for information

gathering and management, and decision making both prior to and during emergency incidents (Davis, 1999). The importance of the emergency operations center has been magnified since the September 11, 2001 attacks in New York and at the Pentagon (Larson, 2002b). However, there is little literature available that specifically addresses emergency operations center design (Jirka, 2006; Perry, 1995). According to Perry (1995) emergency operations centers may be a standalone fully staffed and functioning facility, or can be a space that is reconfigured at the onset of an emergency event. The emergency operations center is the coordination center for emergency response and is the central link in the communications between all levels of government, the private sector and the public (Perry, 1995; Shouldis, 2010).

One of the most important elements of an emergency operations center is its organizational design or layout (Moore, 1998). There are many floor plans that can be utilized. Moore (1998) states:

> Some popular practical floor plans include arena-like, semi-round centers with a central management or information display area in the middle; square or rectangular rooms with various operational positions around the sides and equipment or information technology in the middle or to one side of the room; and clusters or rooms adjoining or near each other with designated operational functions grouped in each room. (p. 5).

Moore (1998) goes on to explain that emergency operations center design is guided by budgetary constraints and the availability of space. Each locality must assess their needs and available resources, and be creative in the design of their emergency operations center (Larson, 2002a; Kuban, 1998).

The United States Department of Defense ([DOD], 2008) has published a guidance document for military emergency operations center planning and design. Chapter four of this document specifically addresses the physical layout of a large, multiple room emergency operations center. However, suggestions from this document can be adapted for smaller, single room centers. The document (DOD, 2008) suggests there should be a minimum of three displays, which are visible to all participants. The displays may be either rear or front projection, or flat panel systems (DOD, 2008). One display should be for briefing information, the second for news briefings and the third for command operations displays (DOD, 2008). In addition, the panels should have teleconferencing capability along with the ability to accept video from various sources, such as staff computers, DVD/VCR players and cable television, for news broadcasts (DOD, 2008).

The DOD (2008) document also describes four general configurations for the emergency operations center. Figure 1 depicts positions in clustered rows. This arrangement allows for personnel to work in teams or groups (DOD, 2008). Figure 2 shows all the positions facing the displays. This allows all personnel to be focused on a common area for information (DOD, 2008). Figure 3 shows positions arranged in a "V" shape. This configuration allows personnel to work in groups while facing displays located in the front of the room (DOD, 2008). Figure 4 shows positions arranged in a square conference arrangement. This configuration is best used with smaller groups and works well when personnel need to focus on a common discussion (DOD, 2008). The document also advises that the total number of stations required will be based on the number of personnel needed to be present (DOD, 2008).

Figure 1. Emergency Operations Center room with personnel in clustered positions.

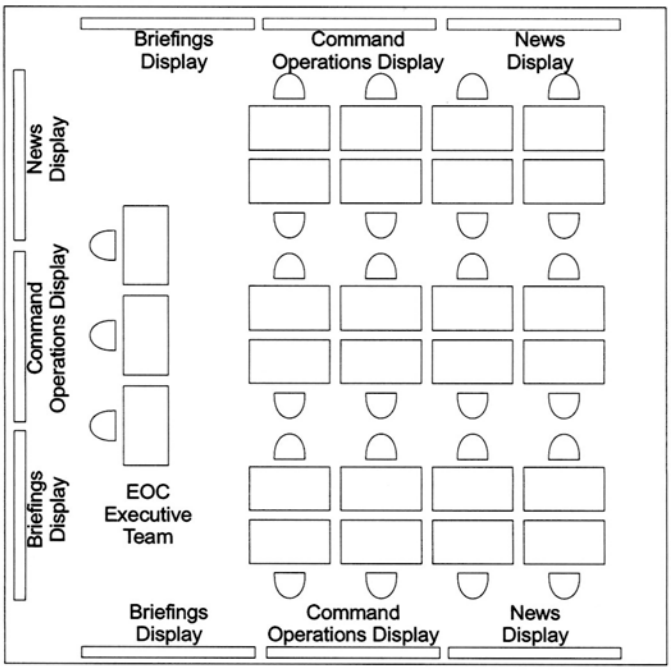


Figure 2. Emergency Operations Center room with personnel in rows facing displays.

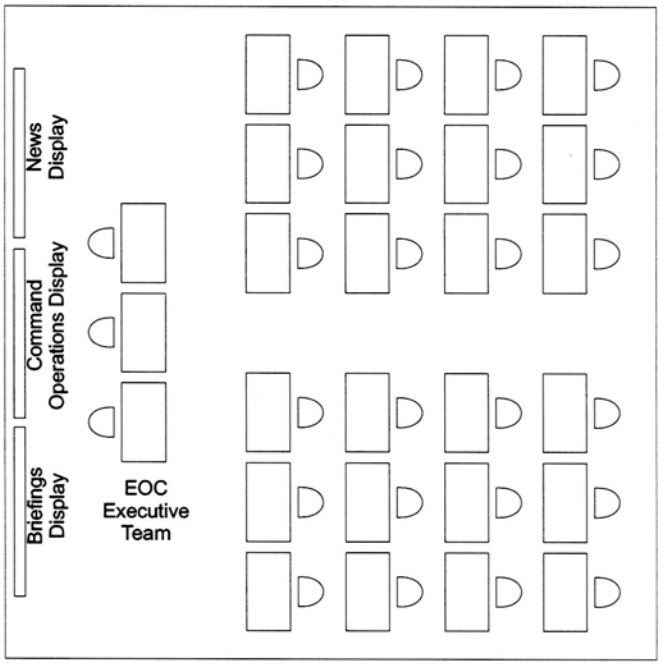


Figure 3. Emergency Operations Center room with personnel in “V” positions facing displays.

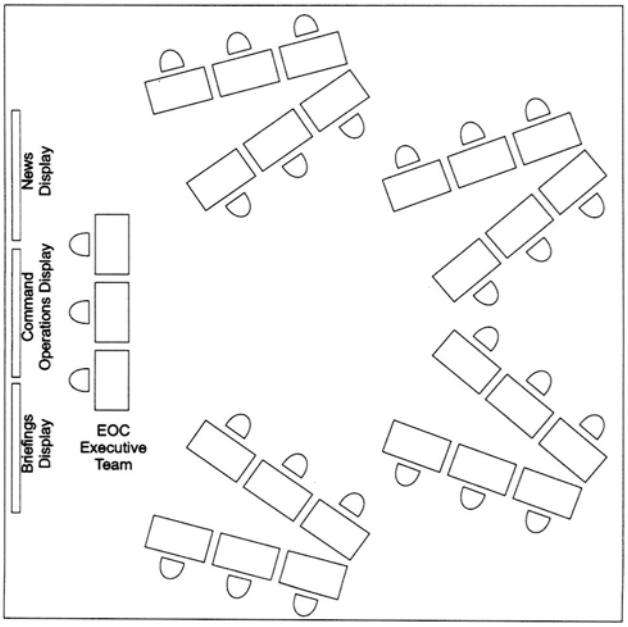
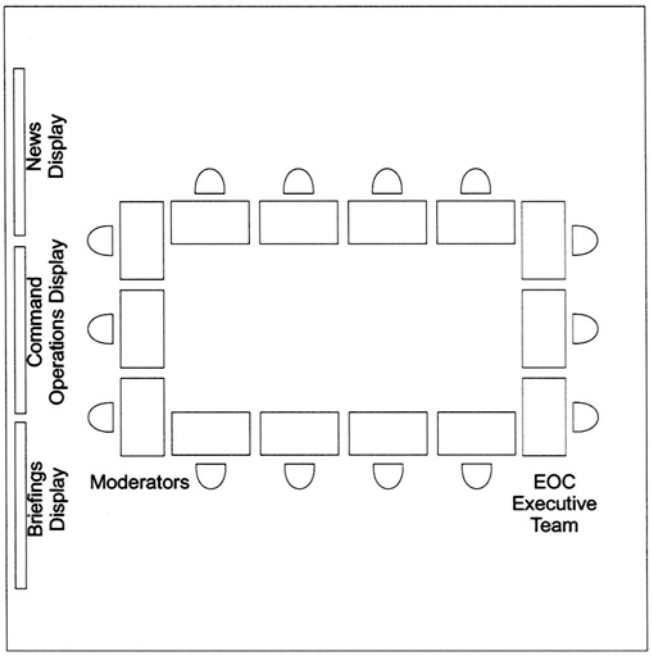


Figure 4. Emergency Operations Center room with personnel in conference arrangement.



In larger municipalities emergency operations centers rarely consist of a single room (Moore, 1998). Usually there are several smaller rooms adjacent to the main emergency operations center. These rooms can have various functions, such as conference rooms for staff briefings, call taking areas, etc. (Moore, 1998). The main emergency operations center area is the focal point for information gathering and dissemination, and resource allocation and deployment (Moore, 1998). However, Moore (1998) states that there are many localities who operate from a single room arrangement quite successfully. However, the emergency operations center should have enough square footage to accommodate the equipment and necessary personnel who will use it (Larson, 2002a). The size of an emergency operation center should be dictated by a jurisdiction's needs, as well as its budget (Larson, 2002a).

The issue of whether the space will be dedicated as an emergency operations center or will have multiple uses must be addressed (Larson, 2002a). Typically in smaller jurisdictions the space that serves as the emergency operations center is also used as meeting and/or classroom space (Perry, 1995; Larson, 2002a). Most often the space is configured for meeting and/or classrooms, but can easily be reconfigured into an emergency operations center (Larson, 2002a). Having a dual purpose site is a very cost effective way of running an emergency operations center (Harris, 2007). Again, each locality must evaluate its needs, budgetary constraints and frequency of events that would require the use of an emergency operations center (Larson, 2002a).

The use of virtual emergency operations centers is another option. Emergency managers and key personnel can communicate through the internet to coordinate emergency response and recovery operations (Krumlauf, 2004; Shouldis, 2010). This design can reduce the

actual amount of space needed for an emergency operations center (Krumlauf, 2004; Shouldis, 2010). The use of virtual emergency operations centers could also save costs by eliminating the purchase of equipment that would only be used occasionally (Krumlauf, 2004). However, for this option to be feasible, a localities' internet infrastructure must be reliable and have the necessary backups to keep emergency managers online (Harris, 2007).

Site security is another concern that should be addressed when designing an emergency operations center. Emergency operations centers must be able to control access into and out of the site (Larson, 2003). Only the personnel who have responsibilities within the emergency operations center should be allowed access (Larson, 2003). During an incident, sensitive information may be discussed, and emergency managers must control what information is released from the emergency operations center (Larson, 2003).

Another consideration while designing an emergency operations center is what equipment and information technology systems will be used. Information management is what makes an effective emergency operations center (Larson, 2003). Davis (1999) states, "The best-prepared Command Centers will be ones that have implemented an enterprise-wide information system designed specifically for event management" (p. 3). Davis (1999) advises that information systems must be equipped with: (a) Two-way communications equipment – to send and receive information between employees, customer and mutual aid agencies (both public and private sector). Multiple means of communication (such as telephone, cellular telephone, radio, faxes and the internet) are essential to sharing information (Moore, 1999). (b) Automated response and recovery checklists – to ensure major functions are tracked and reported as they are completed. (c) Alert notification system – to be able to track and log

various notifications and messages to and from the emergency operations center (Moore, 1999). Some equipment and supplies should be kept on site, while other "low use" items can be made available through prearranged agreements with local vendors (Larson, 2002a).

There are several computer-based software programs on the market designed to manage emergency operations center information. One such program is Web-EOC. In an article, Sibley (1999) describes the Web-EOC software. The software uses the internet to display and manage data and information throughout the emergency operations center. Information is entered into the system, and tagged to identify the individual or organization that submitted the information. The software can also be used to send messages to anyone who is logged into the software, display various maps, and is capable of both video and voice teleconferencing. In addition, a hard copy of the information can be printed. The software is designed and supported by ESi, which is based in Augusta, Georgia.

Provisions should also be made for technology upgrades to the hardware and software that will be used in the emergency operations center (Larson, 2002b). As technology changes and improves, it will be necessary to update computers and other add-ons. Planning ahead for these changes can reduce the amount of operational and budgetary challenges when the time comes to incorporate newer technologies (Larson, 2002b).

However, Harris (2007) warns that overreliance on technology can adversely affect operations within the emergency operations center. Software systems do fail and hard drives can crash, thus eliminating the ability to use those technologies (Harris, 2007). It is suggested that emergency operations center staff learn to utilize two systems: one using technology and

the other being a paper and pencil based system (Harris, 2007). This way, should the technology fail, emergency operations center staff can still effectively manage.

Requirements for long term operations in adverse conditions must also be made. Larson (2002a) states, “Food and housing can be an issue during multi-day operations” (p. 42). Depending on the emergency event, it may not be safe for personnel to travel to find food and/or sleeping arrangements (Larson, 2002a). Ideally, the emergency operations center site would have an area for food preparation and dining, along with dormitory areas.

In addition, system backups should be incorporated into the emergency operations center design (Larson, 2002b). One of the key functions of any emergency operations center is communication, and for the center to be successful during an emergency event, redundancies must be in place (Harris, 2007). Consideration must be given to scenarios that could render the emergency operations center inoperable (Larson, 2002b). Events to consider include, but are not limited to; the loss of commercial power, loss of backup or generator power, loss of telephone and/or radio communications, other technology failures (such as software and/or hardware failures), and structural damage to the site (Larson, 2002b). Localities may have the need for a second location (fixed or mobile) that can be easily transformed into a functioning emergency operations center (Larson, 2002b). Larson (2002b) states, “Plan ahead [for such events], and then practice that plan” (p.35). Localities must conduct a risk assessment for their proposed emergency operations center site, determine their needs and work within budgetary constraints to mitigate potential circumstances that could make their site inoperable (Larson, 2002a; Larson, 2002b). It is impossible to plan for every possible scenario, but by planning for

system failures emergency managers can quickly respond by adapting an available plan to the current crisis (Larson, 2002b; Larson, 2003).

No single emergency operations center organizational structure can meet the needs of every jurisdiction (Shouldis, 2010). Nor is there any current mandate for jurisdictions to adopt any particular emergency operations center organizational structure (Shouldis, 2010). The organizational structure of an emergency operation center should be dictated by a jurisdiction's needs, as well as its budget (Shouldis, 2010). Also, the organizational structure of an emergency operation center should facilitate information gathering and management, and decision making (Davis, 1999; Shouldis, 2010).

Larson (2003) stated, "An EOC [emergency operations center] should be designed or at least set up around the kind of command and control structure that a given agency or community will be using" (p. 38). Larson (2003) goes on to state that more often than not the structure will resemble the incident command system. Perry (2003) agrees with this notion stating "The emergency operations centre is intimately related to the incident management system employed by responder personnel…" (p. 152). Larson (2003) states, "Operating an EOC [emergency operations center] using an ICS [incident command system] model has been shown to increase effectiveness and coherence during even the most devastating of disasters" (p. 38). By basically mirroring the incident command system structure, an emergency operations center can provide enhanced support to field personnel because they are sharing the same management structure (Larson, 2007; Shouldis, 2010). However, coordination between emergency operations centers using the incident command structure with those that use the emergency support function structure can be problematic because there is no clear one-to-one

relationship between positions within the center (Shouldis, 2010). An example of such a design would be to have the emergency operations center divided into the standard incident command system functions of Operations, Logistics, Plans, Finance and Command or Administrative staff (Larson, 2003; Perry, 2003; Shouldis, 2010).

In this model, like functions are grouped based on the nature of the emergency event (Perry, 2003). The Command or Administrative section is responsible for the overall management of the event, and ensuring that the various sections are coordinated and working together (Larson, 2007). Common roles for this group include setting incident priorities and response goals for the event, handling legal issues, and liaison with other jurisdictions (Perry, 2003). The Planning section handles the planning for the event. Roles for this group include collecting situation and damage assessment data, forecasting event needs, and providing reports to the Command section (Perry, 2003; Larson, 2007). The Operations section is the primary liaison with incident commanders in the field and oversees the personnel that are delivering services (Larson; 2007). This group coordinates and communicates response goals with field commanders and relays the field commanders' progress to the Command section (Perry, 2003). The Logistics section performs functions in support of the overall emergency event. This group is tasked with locating and appropriating the necessary resources to mitigate the event (Perry, 2003; Larson; 2007). The Finance section is responsible for tracking expenditures that are related to the response and recovery from the emergency event (Larson, 2007). One the most important aspects of this model is that it can be tailored to fit the type and magnitude of emergency event being managed (Perry, 2003; Shouldis, 2010).

Moore (1998) wrote that there are two major organizational structures used by emergency operations centers. They are the emergency support function and the traditional model (Moore, 1998; Shouldis, 2010). The emergency support function structure is outlined in the National Response Framework (see appendix) and basically groups like resources into fifteen different numerical categories (Shouldis, 2010). This organizational structure allows for greater operability between various emergency operations centers that adhere to the emergency support function format (Moore, 1998; Larson, 2007; Shouldis, 2010). It also provides flexibility, as emergency operations centers only activate the emergency support functions necessary to mitigate the emergency event (Moore, 1998). However, one of the issues with the emergency support function structure is the span of control (Larson, 2007). There are fifteen emergency support functions, and if all fifteen are activated, you have fifteen people reporting to one emergency manager (Larson, 2007). The incident command system suggests that any single person's span of control should be between three and seven individuals, with five being ideal. Also, coordination between emergency operations centers using the emergency support function structure with those that use the incident command structure can be problematic because there is no clear one-to-one relationship between positions within the center (Shouldis, 2010).

The traditional model is similar, but does not group like resources, nor does it utilize a numerical identification system (Moore, 1998). Various resources are labeled by their disciplines, such as fire, police, public works, etc. (Moore, 1998). The traditional model is also flexible, in that only the disciplines needed to mitigate the emergency event are activated (Moore, 1998). This organizational structure also allows for greater operability between

various emergency operations centers who follow the traditional model format (Moore, 1998). This model is also relatively simple and has straight lines of communication and chain of command within the emergency operations center (Shouldis, 2010). However, coordination between on scene incident command and the emergency operations center can be confusing as there is no one-to-one match of positions between the two (Shouldis, 2010).

Perry (2003) also suggested that there are two commonly used management structures for emergency operations centers. The first structure features an emergency operations center commander. This commander is usually the locality's emergency services director or emergency management director. In this structure, the commander receives input from emergency operations center staff to develop emergency event mitigation and recovery policies (Perry, 1995; Perry, 2003). The commander then seeks approval for those policies (as necessary) from the locality's governing body, and then implements the policies. The second structure utilizes what Perry (1995) describes as, "… a 'disaster management committee' or advisory body separate from the EOC [emergency operations center] commander" (p. 38). This structure is usually headed by an elected official with committee members consisting of key department heads (Perry, 1995; Perry, 2003). The emergency operations center commander may develop mitigation and recovery policies with the committee reviewing those policies prior to implementation, or the policies may be developed by the emergency operations center commander with the committee (Perry, 1995; Perry, 2003). Regardless of how the policies are developed, they are implemented by the emergency operations center commander.

In addition to the literature review above, interviews and personal observations at neighboring emergency operations centers were conducted to ascertain how centers in other

localities in southwest Virginia are designed. Specifically, data was collected on the physical layout/floor plan of each emergency operations center, was the site multipurpose, what technologies each center has incorporated into their operations, and were there any other notable features present. The emergency operations center manager for each site was contacted and asked to participate in the interviews and to provide a brief tour of their respective center. Additionally, each manager was informed of the purpose of the interview and tour.

Melissa Foster of the Lynchburg Emergency Communications Center (also known as Lyn Comm), Virginia, was interviewed on June 15, 2010 at the Lynchburg Emergency Communications Center. The emergency operations center is a single large room, co-located within the City's emergency communications center. Foster advised that the physical layout of the emergency operations center varies, and depends on what participants are active within the center and the type of incident being handled. However, there are permanent locations/workspaces set up for geographic information system operators, 911 operators and amateur radio operators in the rear of the room. The emergency operations center utilizes the emergency support function model for their organizational structure, again only activating those functions needed for the type of incident being handled. The room is multipurpose, serving as a classroom when needed. The technology incorporated into the emergency operations center includes three flat screen televisions linked to a single computer at the front of the room, with the capability to connect two additional computers. In addition, the computers and equipment needed for the geographic information system, 911 operators and amateur radio station are present within their respective locations at the rear of the room. One

interesting feature noted was the total use of technology during operations. Essentially, they have eliminated the use of paper incident command system forms. Their computer aided dispatch software has the ability to handle messaging between the various participants within the emergency operations center, and is able to track the progress of incident goals and objectives as they are managed (personal communication, June 15, 2010).

Division Chief of Operations Billy Ferguson of the Franklin County Department of Public Safety, Virginia, was interviewed on June 16, 2010, at the Franklin County Emergency Operations Center. The emergency operations center is a single medium sized room, co-located within the Department of Public Safety's main building. Ferguson advised that the physical layout of the emergency operations center was in the process of being remodeled. The finished center will have dedicated locations/workspaces arranged around the exterior walls of the room that follow the emergency support function model, which is the organizational structure of their center. During operations only the emergency support functions needed are activated. The room is single purpose, only serving as an emergency operations center. The technology incorporated into the emergency operations center includes four flat screen televisions (two on each side of the room) and one multimedia projector pointed to one side of the room. All are linked to a single audio/visual control system, with the capability to display information from various computers, cable television stations and DVD and/or VHS devices. In addition, there is an area set aside for amateur radio operators. An interesting feature noted was the use of educational classroom management software to communicate within the center and to replace the use of paper incident command system forms (personal communication, June 16, 2010).

The Patrick County, Virginia, Emergency Management Coordinator Steve Allen was interviewed on June 17, 2010 at the Patrick County Emergency Operations Center. The emergency operations center is a small room located within the County Administration Building. The room is multipurpose, serving primarily as a conference room. It is furnished with one large table with adequate seating, along with a computer connected to a multimedia projector. The center does not use any event management software, but does use electronic versions of the incident command system forms during emergency events. The organizational structure of the emergency operations center is similar to the disaster management by committee structure described by Perry (1995). As issues come into the center, the group jointly discusses them, makes the necessary decisions and then implements the appropriate actions (personal communication, June 17, 2010).

Director Wes Ashley and Steve Fields of the Martinsville-Henry County Communications Center were interviewed on June 17, 2010 at the Martinsville-Henry County Communications Center. As previously mentioned, Martinsville and Henry County has a joint emergency operations center, which is co-located within the communications center. This joint emergency operations center is only staffed when activated, and the site serves a dual role as a meeting/training room for the communications center. The emergency operations center is a large room with dedicated locations/workspaces, each with computers, arranged around the exterior walls of the room. In addition there is a large conference table with chairs in the center of the room. The room is equipped with two televisions and two multimedia projectors, which are connected to computers capable of displaying geographic information system data and computer aided dispatch information. When activated, the organizational structure of the

center is based upon the emergency support function model with additional workstations for outside agencies, such as the Red Cross. A notable feature of the center was its ability to teleconference with other emergency operations centers, if they are so equipped (personal communication, June 17, 2010).

Director Bernard Brown of the Danville Emergency Services, Virginia, was interviewed on June 23, 2010, at the Danville Emergency Operations Center. The center is co-located with their communications center. The emergency operations center is a large room resembling a college classroom, with the head of the room elevated, and is equipped with three large flat screen televisions, one of which is equipped with a touch-sensitive screen allowing tactile input. The organizational structure of the center is by the emergency support function model. The room is multipurpose and is used for various classes. The center does not use any event management software, but does use paper versions of the incident command system forms during emergency events. Brown advised that Danville is in the process of building a new emergency communications center that will also house a new emergency operations center. However, the design specifications of this new emergency operations center were not available at the time this manuscript was being written (personal communication, June 23, 2010).

Emergency Management Coordinator Mike Guzo of the Roanoke Emergency Services, Virginia, was interviewed on June 24, 2010, at the Roanoke Emergency Operations Center. The center is located in the City Municipal Building. The emergency operations center is a large room with tables and chairs throughout, and serves as a meeting site and classroom. The center can be arranged in various configurations, based on what participants are active within the center and the type of incident being handled. The organizational structure of the

emergency operations center is a hybrid combination of the emergency support function and the traditional models described by Moore (1998). Participants are placed by the appropriate emergency support function and then grouped by similar functions, such as representatives of law enforcement, fire and emergency medical services would be a single group. The center is equipped with computers and three multimedia projectors that have the capability of displaying geographic information system data and computer aided dispatch information. In addition, there is an area set aside for amateur radio operators. The center uses paper versions of the incident command system forms during emergency events; however, they are transitioning to the use of emergency operations center management software. The software they have chosen is Web-EOC as described by Sibley (1999). As a point of interest, Guzo has submitted a regional grant for localities to "buy" into a regional version of Web-EOC. Should this happen, emergency operations center throughout the region, including Martinsville, would have access to this software (if they choose to participate) and would be able to share information region-wide (personal communication, June 24, 2010).

Procedures

This applied research project utilized the descriptive research method to explore available literature for emergency operations center design elements and technologies that could be integrated into the City of Martinsville's emergency operations center making it more efficient and effective. The procedures used to gather the needed information began with recognition of the stated research problem; which is, the City of Martinsville has an emergency operations center that is not functional in its design and use of technology, which causes confusion and inconsistencies when the emergency operations center is activated. The data

collected during the research was used to answer the following research questions: (a) What are considered effective design characteristics of emergency operations centers? (b) What are considered industry best practices for the use of technology in emergency operations centers? (c) What factors should the City of Martinsville use in redesigning its emergency operations center?

The first phase of the applied research project was to conduct a review of available, applicable literature. Research literature for this applied research project came from written texts, scholarly journals, trade journals, fire service publications, and internet databases and sites that were discovered while performing research for this paper. Research was conducted at the National Fire Academy's Learning Resource Center located in Emmitsburg, Maryland. Utilizing the National Fire Academy's Learning Resource Center Card Catalog, a search was conducted to indentify literature related to emergency operation centers. In addition, research was done online through the Homeland Security Digital Library for literature pertaining to emergency operations centers. The focus of the research was to identify relevant sources of information that directly related to the research problem, research questions, and ultimately the intended purpose of this applied research project.

Secondly, interviews and personal observations at neighboring emergency operations centers were conducted to gather additional information to answer the research questions. These interviews and personal observations were conducted to ascertain how emergency operations centers in other localities in southwest Virginia are designed, what floor plan was utilized and what technologies they have incorporated into their emergency operations center.

Emergency operations centers were selected based on their geographical location within southwest Virginia, and their proximity to the City of Martinsville.

The limited number of interviews and personal observations at emergency operations centers and the lack of a more formal survey instrument are known limitations with this applied research project. Although 100% of the emergency operations centers contacted participated in the interviews and personal observations, only six centers were contacted. It is reasonable to expect that a more formal survey instrument distributed to a larger geographic area would have yielded more in depth data from a broader demographic of emergency operations centers. Also, as noted by Jirka (2006), there is little scholarly research on emergency operations center design, specifically what elements make an emergency operations center more efficient and effective.

Results

In this applied research project, three research questions were developed based upon the problem statement and purpose of the research. Utilizing the descriptive research method, relevant literature was collected and examined for information to answer each of the research questions. In addition, interviews and personal observations at neighboring emergency operations centers were conducted to gather more data related to the research questions. The results of the literature and site visits are organized by research question.

Research Question #1: What are considered effective design characteristics of emergency operations centers?

One of the most important elements of an emergency operations center is its design or layout (Moore, 1998). The observations of Perry (1995), Moore (1998), Shouldis (2010), Larson

(2002a) and the DOD (2008) all provide various descriptions of emergency operations center design suggestions. All of the emergency operations centers interviewed varied in size, but all consisted of a single room design. However, it was noted that emergency operations center design is guided by a jurisdiction's budget and the availability of space (Moore, 1998). Each locality must assess their needs and available resources, and be creative in the design of their emergency operations center (Larson, 2002a; Kuban, 1998).

Another design element is whether the space will be dedicated as an emergency operations center or have multiple uses (Perry, 1995; Larson, 2002a). In some localities emergency operations centers are standalone, fully staffed and functioning facilities (Perry, 1995). In other localities the emergency operations center space can be reconfigured and be used as a meeting and/or classroom site (Perry, 1995; Larson, 2002a). During the interviews at local emergency operations centers, only one (Franklin County) was identified as having standalone space for their center. Having a site with multiple purposes is a cost effective way of having an emergency operations center (Harris, 2007). Again, each locality must evaluate its needs, budgetary constraints and frequency of events that would require the use of an emergency operations center (Larson, 2002a).

Other considerations in the design or layout of an emergency operations center include site security, ongoing operations and utility backup systems. As the center for information gathering and management, and decision making both prior to and during emergency incidents, emergency operations centers must be able to control access into and out of the site (Davis, 1999; Larson, 2003). Also, requirements for long term operations in adverse conditions must also be made. Depending on the emergency event, it may not be safe for personnel to travel to

find food and/or sleeping arrangements (Larson, 2002a). Finally, system backups should be incorporated into the emergency operations center design (Larson, 2002b). One of the key functions of any emergency operations center is communication, and for the center to be successful during an emergency event, redundant utility systems must be in place (Harris, 2007). It is impossible to plan for every possible scenario, but by planning for system failures emergency managers can quickly respond by adapting an available plan to the current crisis (Larson, 2002b; Larson, 2003).

The literature review outlined several different organization structure models for emergency operations centers. Larson (2003) and Perry (2003) both suggest that the organization structure of any emergency operations center should resemble the command and control structure used by the locality. Larson (2003) suggests that an emergency operations center using the incident command system organizational structure has been shown to increase effectiveness and coherence during operations. By basically mirroring the incident command system structure, an emergency operations center can provide enhanced support to field personnel because they are sharing the same management structure (Larson, 2007; Shouldis, 2010). An example of such a design would be to have the emergency operations center divided into the standard incident command system functions of Operations, Logistics, Plans, Finance and Command or Administrative staff (Larson, 2003; Perry, 2003; Shouldis, 2010).

Coordination between emergency operations centers using the incident command structure and those using other organization structure models can be problematic (Shouldis, 2010). During the interviews at the emergency operations centers, it was noted that four of the six centers use the emergency support function model for their organizational structure. Of the

other two, one (Patrick County) uses a disaster management by committee structure, while the other (Roanoke) uses a hybrid combination of the emergency support function and the traditional models. The literature review did not reveal any current mandate for jurisdictions to adopt any particular emergency operations center organizational structure (Shouldis, 2010). The organizational structure of an emergency operation center should be dictated by a localities needs, available resources and its budget (Shouldis, 2010). The most important aspect of the organizational structure of an emergency operation center is that it must facilitate information gathering and management, and decision making (Davis, 1999; Shouldis, 2010).

Research Question #2: What are considered industry best practices for the use of technology in emergency operations centers?

The literature review and interviews at the emergency operations centers revealed some suggestions for the use of technology, which included equipment and software. The guidance document published by the DOD (2008) suggests that there should be a minimum of three displays within the emergency operations center. These displays can be either projection or flat panel systems, and should display briefing information, news and command operations data (DOD, 2008). The displays should also have the capability to display video feed from various sources, such as staff computers, DVD/VCR players and television news broadcasts (DOD, 2008). During the interviews at the emergency operations centers, it was noted that five of the six centers had at least three displays. Only one (Patrick County) had a single multimedia projector.

The use of virtual emergency operations centers is becoming more common place. Technology can now allow essential personnel to communicate through the internet to

coordinate emergency response and recovery operations (Krumlauf, 2004; Shouldis, 2010). The use of virtual emergency operations centers could save costs by reducing the amount of space and equipment needed within the center (Krumlauf, 2004). However, it was noted that for this option to be feasible, a localities' internet infrastructure must be reliable and have the necessary backups to keep emergency managers online (Harris, 2007). None of the emergency operations centers interviewed had a virtual component to their center. Only one of the emergency operations centers interviewed (Martinsville-Henry County) had teleconferencing capability.

The type of equipment and information technology systems used in emergency operations centers must be carefully considered. Information management is one of the essential elements that make an emergency operations center effective (Davis, 1999; Larson, 2003). Information management systems utilize two-way communication equipment, automated response and recovery check lists and some type of alert notification system (Davis, 1999; Moore, 1999). Emergency operations center management software is also available. Such software allows for information to be collected, managed and shared with center staff (Sibley, 1999). Provisions should also be made for technology upgrades of any hardware and software used within the center (Larson, 2002b). In addition, Harris (2007) warns against an over-reliance on technology. Software systems do fail and hard drives can crash, thus eliminating the ability to use those technologies (Harris, 2007). It is suggested that emergency operations center staff learn to utilize two systems: one using technology and the other being a paper and pencil based system (Harris, 2007). This way, should the technology fail, emergency operations center staff can still effectively manage.

During the interviews at the emergency operations centers, it was noted that each site used technology at varying degrees. All six of the centers had computers and the ability to access the internet for information, send and receive e-mails, etc. Two of the six (Lynchburg and Franklin County) totally use technology for the management of information and recording incident operations in lieu of paper-based forms. While two others (Danville and Patrick County) only use paper incident command system forms to manage and record incident operations during an incident. The remaining two (Martinsville-Henry County and Roanoke) use a combination of technology and paper-based incident command system forms during their operations. Also, it should be noted that one of these localities (Roanoke) is transitioning to an all technology-based information management system.

Research Question #3: What factors should the City of Martinsville use in redesigning its emergency operations center?

Factors the City of Martinsville should consider in redesigning its emergency operations center are the efficiency of its current site, the City's organizational design and layout needs for a center and the availability of resources to complete such a project. As noted in the Background and Significance Section, several issues with our current center were realized during the activation in February of 2010. The primary reason identified for those short comings was that the site itself was not properly planned and designed. Knowing that our current center design and layout does not meet our needs or expectations provides the framework to initiate improvements.

The literature review and interviews provide information concerning emergency operations center designs and organizational structure, as well as information on the use of

technologies. No single emergency operations center design, organizational structure or technology was determined to be the most efficient. Nor is there any current mandate for jurisdictions to adopt any particular emergency operations center design or organizational structure (Shouldis, 2010). Based on the literature review, the design, organizational structure and use of technology in the City's emergency operations center should be determined by our needs, and available budget.

Discussion

The literature review discovered several suggestions for emergency operations center designs (Perry, 1995; Moore, 1998; Shouldis, 2010; Larson, 2002a; DOD, 2008). These floor plans ranged in size from a single room site to larger multi room designs (Perry, 1995; Moore, 1998; DOD, 2008). All of the local emergency operations centers interviewed utilized a single room design. In addition, it must be determined if the site for the emergency operations center will be used for other purposes, such a meeting space and/or classrooms (Perry, 1995; Larson, 2002a; Harris, 2007). During the interviews at local emergency operations centers, only one was identified as having stand-alone space for their center. Having a site with multiple purposes is a cost effective way of having an emergency operations center (Harris, 2007). As noted previously, the size and layout of an emergency operations center is dependent on the needs of the locality, frequency of use, availability of space and the availability of budget funds (Moore, 1998; Larson, 2002a; Kuban, 1998).

The literature review also outlined several different organization structure models for emergency operations centers. Of these suggestions, the utilization of an organization structure that resembles the command and control structure used by the locality seems most

logical (Larson, 2003; Perry, 2003; Larson, 2007; Shouldis, 2010). Larson (2003) suggests that an emergency operations center using the incident command system organizational structure has been shown to increase effectiveness and coherence during operations. By basically mirroring the incident command system structure, an emergency operations center can provide enhanced support to field personnel because they are sharing the same management structure (Larson, 2007; Shouldis, 2010). While attending the Executive Analysis of Fire Service Operations in Emergency Management course at the National Fire Academy, students utilized the incident command system organizational structure to manage mock disasters in a classroom setting. The practical application of this organizational structure model flowed well, seeming to validate Larson's (2003) claims that this model can increase effectiveness and coherence during emergency operations center activations.

However, it was noted during interviews at local emergency operations centers that four of the six centers use the emergency support function model for their organizational structure. Of the other two, one uses a disaster management by committee structure, while the other uses a hybrid combination of the emergency support function and the traditional models. Coordination between emergency operations center that are using different organizational structures can be problematic (Shouldis, 2010).

Information management is one of the essential elements that make an emergency operations centers effective (Davis, 1999; Larson, 2003). Information management systems that must be considered include displays, communications equipment, computer hardware and software programs (Davis, 1999; Moore, 1999; Sibley, 1999; DOD, 2008). Provisions should also be made for technology upgrades of any hardware and software used within the center

(Larson, 2002b). During the interviews at local emergency operations centers, it was noted that each site used technology at varying degrees. All six of the centers had computers and the ability to access the internet for information, send and receive e-mails, etc. Two of the six totally use technology for the management of information and recording incident operations in lieu of paper-based forms. While two others only use paper incident command system forms to manage and record incident operations during an incident. The remaining two use a combination of technology and paper-based incident command system forms during their operations. Harris (2007) warns against an overreliance on technology. Software systems do fail and hard drives can crash, thus eliminating the ability to use those technologies (Harris, 2007). It is suggested that emergency operations center staff learn to utilize two systems: one using technology and the other being a paper and pencil based system (Harris, 2007). This way, should the technology fail, emergency operations center staff can still effectively manage.

In summary, emergency operations centers are the hub for information gathering and management, and decision making during an emergency incident (Perry, 1995; Davis, 1999). However, there is limited scholarly literature related to emergency operations center design (Jirka, 2006; Perry, 1995). Nor is there any current mandate for jurisdictions to adopt any particular emergency operations center design or organizational structure (Shouldis, 2010). Also, the use of technology to enhance the management of information within the emergency operations center is becoming more commonplace. At best, it seems that emergency operations center design is guided by budgetary constraints and the availability of space (Moore, 1998). Each locality must assess their needs and available resources, and be creative in the design of their emergency operations center (Larson, 2002a; Kuban, 1998).

Recommendations

The purpose of this applied research paper is to identify the best industry practices and designs for effective emergency operations centers, and to determine which design elements and technologies the City of Martinsville should integrate into its center. Based on the knowledge gained during the Executive Analysis of Fire Service Operations in Emergency Management course and the findings of this applied research project, the following are recommendations for City Administration and Emergency Management Coordinator to consider in redesigning the current site and implementing standard operating guidelines for the setup and use technology within the city's emergency operations center:

1. Utilize the existing emergency operations center site. With the current economic condition of the city, a new facility is not a feasible option. City officials previously determined that the city's Headquarters Fire & EMS Station was the best suited site for an emergency operations center. This location can be easily secured, and is adjacent to the station's kitchen. The station also has a dormitory area with shower and restroom facilities, in the event of long-term operations.
2. Establish a standard organizational structure for the emergency operations center. A standard organizational structure must be implemented by the City. It is recommended that the incident command system model be adopted. City departments already utilize the incident command system as their command and control structure at emergency scenes. The practical application of this model during the Executive Analysis of Fire Service Operations in Emergency Management course and the findings of this applied research project support adopting the incident command system organizational

structure. This model has been shown to increase effectiveness and coherence in the emergency operations center during ongoing operations.

3. Develop a plan for the coordination of information with emergency operations centers utilizing other organization structure models. The findings of this applied research project indicated that coordination between emergency operations centers using different organization structure models can be problematic. However, knowing the organizational structure of neighboring jurisdictions, measures can be taken to facilitate the flow of information between various emergency operations centers.
4. Incorporate the use of technology to enhance information management. The use of information management systems is becoming more commonplace. The City should take advantage of this opportunity while redesigning its emergency operations center to include multiple displays, communications equipment, computer hardware and software programs. Provisions should also be made for future technology upgrades of any hardware and software used within the center.
5. Implement a standard system for information management. It is recommended that the City train its personnel in the use of the paper incident command system forms and implement their use. It is suggested that emergency operations center staff learn to utilize two systems: one being a paper and pencil based system and the other using technology. This way, should the technology fail, emergency operations center staff can still effectively manage.
6. Explore the possibilities of a regional grant for localities to utilize a regional version of Web-EOC. During the interview with Mike Guzo of the Roanoke Emergency Services, he

made mention that he was preparing such a grant request. It is suggested that City Administration and Emergency Management Coordinator coordinate with Mr. Guzo and be a part of that process.

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Appendix

List of Emergency Support Functions

ESF #1 – Transportation	• Aviation/airspace management and control • Transportation safety • Restoration/recovery of transportation infrastructure • Movement restrictions • Damage and impact assessment
ESF #2 – Communications	• Coordination with telecommunications and information technology industries • Restoration and repair of telecommunications infrastructure • Protection, restoration, and sustainment of national cyber and information technology resources • Oversight of communications within the Federal incident management and response structures
ESF #3 – Public Works and Engineering	• Infrastructure protection and emergency repair • Infrastructure restoration • Engineering services and construction management • Emergency contracting support for life-saving and life-sustaining services
ESF #4 – Firefighting	• Coordination of Federal firefighting activities • Support to wildland, rural, and urban firefighting operations

ESF #5 – Emergency Management	• Coordination of incident management and response efforts • Issuance of mission assignments • Resource and human capital • Incident action planning • Financial management
ESF #6 – Mass Care, Emergency Assistance, Housing, and Human Services	• Mass care • Emergency assistance • Disaster housing • Human services
ESF #7 – Logistics Management and Resource Support	• Comprehensive, national incident logistics planning, management, and sustainment capability • Resource support (facility space, office equipment and supplies, contracting services, etc.)
ESF #8 – Public Health and Medical Services	• Public health • Medical • Mental health services • Mass fatality management
ESF #9 – Search and Rescue	• Life-saving assistance • Search and rescue operations

ESF #10 – Oil and Hazardous Materials Response	• Oil and hazardous materials (chemical, biological, radiological, etc.) response • Environmental short- and long-term cleanup
ESF #11 – Agriculture and Natural Resources	• Nutrition assistance • Animal and plant disease and pest response • Food safety and security • Natural and cultural resources and historic properties protection and restoration • Safety and well-being of household pets
ESF #12 – Energy	• Energy infrastructure assessment, repair, and restoration • Energy industry utilities coordination • Energy forecast
ESF #13 – Public Safety and Security	• Facility and resource security • Security planning and technical resource assistance • Public safety and security support • Support to access, traffic, and crowd control
ESF #14 – Long-Term Community Recovery	• Social and economic community impact assessment • Long-term community recovery assistance to States, local governments, and the private sector • Analysis and review of mitigation program implementation

ESF #15 – External Affairs	• Emergency public information and protective action guidance • Media and community relations • Congressional and international affairs • Tribal and insular affairs

(DHS, 2008)